LIMITED

WRD/MKG/INF/L.114
2 October 1963

ORIGINAL : FRENCH

UNITED NATIONS

ECONOMIC COMMISSION FOR ASIA AND THE FAR EAST.

CAMBODIA, LAOS, THAILAND AND VIET-NAM

Committee for Coordination of Investigations
of the Lower Mekong Basin .

CAMBODIA: SEDIMENTATION RATE OF THE GREAT LAKE

by

Jean Pierre CARBONNEL
Sedimentologist

CAMBODIA: SEDIMENTATION RATE OF THE GREAT LAKE IN CAMBODIA

A previous note 1/ explained the sedimentation problem arising in connexion with the Great Lake in Cambodia.

Of the two main questions which the French Sedimentation Mission was asked to answer the more important undoubtedly is that of the sedimentation rate of the Basin during the last centuries.

The computation of this rate necessarily is an average between two dated stratigraphical levels, one of which necessarily is the present upper level of sediments, that is our own time.

The deeper the second level will be, i.e. the older, the more the computed sedimentation rate is likely to be truly representative of the investigated sedimentation process.

That is the reason why we endeavoured in an initial stage survey to establish a coherent and continuous stratigraphy of the recent - or presumed to be so - sediments of the Great Lake. This enabled us to show three characteristic levels (representing different silting conditions, i.e. different climate conditions) which we called: "current silt", "intermediate level" and "ancient silt".

All we had to do after this was to find one or several datable levels.

/ The Great Lake

1/ For more detailed considerations on the general sedimentation conditions and the stratigraphy of the deposits, see last issue of Cahiers du Pacifique in which we published the resuls of the Mission Française de Sédimentologie (French Sedimentation Mission) for 1963.

The Great Lake always attracted the various human groups who lived in the region since prehistoric times. This is evident from the fine palafitte remains at Samrong Sen, South-East of Phnom Spong (region of Kompong Chhnang) dating back to 500 years B.C. approximately. If the banks of the Great Lake have been inhabited for a very long time, it is logical to assume that the sediment layers of the Lake will contain evidence of the presence of man in the shape of debris such as earthenware, piles... Research operations undertaken in the hope of finding such evidence yielded a fairly great number of objects; these, however, have as a rule been found by fishermen and did not give any conclusive results, as the fishermen could not determine the depth at which or even the place in which the objects had been found.

However, as a rule, earthenware debris are found on or near the surface.

These debris are mostly identical with the currently manufactured articles, and it is very difficult to tell how ancient they may be.

We found the "current silt" to be very rich in organic matter. This organic matter comes from vegetable debris of the inundated forest, washed every year by the floods. In high water period, many fragments of wood float on the Lake. The current silt, although it contains a very high percentage of organic matter, seldom contains fragments - branches, twigs or trunks - sufficiently large to be identified.

This is due either to a very rapid decomposition of organic matters, or to a very low sedimentation which leaves the debris for very long time in contact with oxidizing agents, that is on the surface of the sediment.

We already reported, under the "current silt" the presence of a constant level in sedimentary lacustrial series: the "ancient silt".

The word "ancient", applied to this layer, is explained by two reasons:

/ classically

classically, this layer corresponds by its facies to the "ancient alluvium" of the French geologists in Indochina; moreover, it is constituted by a very closely packed clay which underwent an already advanced diagenesis; now, clays and silts, as a rule only pack very slowly especially when the overlying deposits are not very thick, which is the case for the "ancient silt" of the Great Lake.

All this would go to show that the Great Lake sediments have a fairly long historical record and that the present sedimentation might not be as rapid as one had felt inclined to believe until now.

This seemingly long history of lacustrian deposits might give reason to expect the discorvery of fossil animal species, currently extinct. In the absence of absolutely precise age data, such fossils would have made it possible to establish a relative chronology of these deposits.

The macrofossils found in the "current" silt are identical to modern types. There are not many species anyway. Mostly Lamellibranches (Modiola, Dreissensia, Unio, Corbicula) and Gasteropodes (Canidia, Melania, Viviparus, Amularia). Altogether about twenty species which do not seem to have varied since the "current" silt began depositing.

It may be added that two other layers - intermediate level and ancient silt - contain no macrofauna.

This scarcity of fossils let us to undertake a study the pollens and diatoma of the Great Lake sediments. The pollens are being studied by M. GUINET of the Ecole Française d'Extrême-Orient: the diatoma by M. FUSEZ of the Muséum National d'Histoire Naturelle of Paris. These studies, beside their undisputable theoretical interest, will perhaps make it possible to establish distant correlations between the various quaternary deposits of Indochina, and perhaps even of South-East Asia in general.

We then were lucky to find at the base of the "current"silt sufficiently abundant vegetable debris to make an age evaluation, through C^{14}, possible.

/ AGE EVALUATION

AGE EVALUATION

The age evaluation of vegetable debris through C14 was conducted by the Service d'électronique physique of the Centre d'Etudes Nucléaires of Saclay. We want to record our appreciation to this organization and more especially to Madame DELIBRIAS for the celerity which the analysis was conducted and the valuable help thus given in our work.

The sampling, the sending and the analysis were carried out according to the standards of that laboratory.

The vegetable debris are 5720 ± 300 years old.

The accuracy of this measurement chiefly depends on the statistical fluctuation. This fluctuation increases with the age of the sample, but decreases when the measured time increases. For 5720 years and 24 hours, the standard deviation would be about 220 years, which means that if this was be only source of error, the age itself would be 5720 ± 220 years with a 66% degree of reliability, or ± 440 years with a 95% reliability degree.

In the light of its own experimentation, the Service d'électronique physique of Saclay has considered this standard deviation to be 300 years.

GEOGRAPHICAL AND STRATIGRAPHICAL POSITION

The region in which the fossil debris where found is located on the "straits" separating what is called the Small Lake from the Great Lake.

In this spot, there is an accumulation of "current" silt, 180 cm thick. It is at the base of this silt, between 180 and 190 cm the above mentioned wood fragments are found. Then comes what is called the "intermediate" level and the "ancient" silt.

This stratigraphical position not only gives the time that was necessary for the accumulation of the 180 cm silt layer in the place in question, but also a date for the base of the "current" clay or the contact between our "intermediate" level and the "current" silt. This contact is constant in all the cross-sections made so far in the Great Lake.

/ One may

One may therefore say that it corresponds to a general phenomenom in all the region.

If we date this contact, we also dat the top or the base of two sedimentary, i.e. climatic, episodes.

AVERAGE SILTING UP RATE

For easier computation and to start from a necessarily accurate minimum figure, we decided to take the 5000 year mark as the minimum age for our contact.

On the one hand, the sub-lacustrian relief left by the "ancient" clay not being regular; on the other hand, the current relief being regularized and uniformly flat, it goes without saying that the thickness of the "current" silt varies from one place to another in the region of the Great Lake. This thickness may vary from zero (region in front of the Phnom Krom) to over 5 metres (region bordering the Tonlé Chhma).

We computed that the average thickness given by our drillings was about 115 cm. This average thickness is obviously difficult to know with precision: stratigraphical cross-sections would have to be multiplied to gain an accurate idea.

However, we believe that 250 cm is the maximum that can be considered for this average. In this case, the average silting up rate would be 0,5 mm per year.

This figure is low and may not seem to reflect certain present conditions. As a matter of fact, through a entirely different process (observation of exceptional floods for the last 80 years) we came to the conclusion that in the first meter of the sediments of the Great Lake, the average silting up speed could vary from 2 to 8 mm per annum.

These two results should not be considered as contradictory. It is quite logical to think that the erosion and sedimentation conditions may have accelerated with the time and the new conditions created by the increasing rate of settlement of man in the area (deforestation, samras, special fishing systems).

/ Our result

Our result should be considered as an average of sedimentation conditions over 5000 years, therefore not taking into account local and time variations which may have affected the Great Lake over the whole period.

The sedimentation picture of the Great Lake region which we shall submit the end of the year, and which will extend over a little more than a complete hydrological cycle, will give us the average thickness of sediments deposited during that cycle in the Great Lake.

We thus will be in a position to check this result with the result given above, and to see whether present sedimentation conditions are very different from the average conditions we have described.

SPECIFIC EROSION OF THE BASIN

We have computed, for the whole system of the Great Lake watersheds, the erosion corresponding to 0.5 mm.

The surface of the Great Lake varying from one to three according to whether its low water level or its high water level are considered, we made the computation for these two extreme data.

- minimum surface: about 3 000 Km^2.
  Taking as the average density of the materials transported a value of 2.2., we arrive at a minimum specific erosion of 48 tons/Km^2/year (for each square kilometer of the watershed)
- maximum surface: about 9 000 Km^2
  In this case and for the same density we arrive at: 145 tons/Km^2/year.

We therefore can consider that the average specifical erosion oscillates around 100 tons/Km^2/year.

This yearly erosion figure may seem low; but we must bear in mind that:

/ - it is

- it is an average, computed over 5 000 years;
- it is ap lied to the whole basin, whose superficy is 68,000 Km^2; and that it may therefore be higher for some parts of the basin and lower for some others.
- the region under investigation has a very ancient geological history where the accretion has been going on for a very long time. Actually, the erosion currently observed is essentially due to the activity of men. If natural conditions had not been modified, there is no doubt that the basin would currently be in a state of equilibrium in which erosion would pratically be nil.
- the material brought by the Mekong in high water periods is negligible in the Great Lake proper and consequently does in no way modify the accumulation rate in the Great Lake. All alluvial matters transported by the Mekong as it flows up towards the Great Lake settle in the region between Kompong-Chhnang and the Seuil de Snoc Trou, an area which the Cambodians significantly called VEAL POK, that is: "mud plain".
  The difference in the transport between the high and low water stages of the Tonlé Sap corresponds to the amount of silt deposited in the VEAL POK.
  In 1963, we attached to the sedimentation picture of the Great Lake the 'budget' for that region, where sedimentation phenomena seem to be especially important for the future dam on the Tonlé Sap.

/ CONCLUSIONS

CONCLUSIONS

In this note, two new elements in the sedimentation problem in connexion with the Great Lake in Cambodia are submitted:

- the average accumulation rate of the sediments of the Great Lake is very low. It is about 0.5 mm per year.

  The notion according to which this average accumulation rate might have varied with the time and geomorphological conditions, especially in recent times, should not be rejected.

  The sedimentation 'budget' of the Great Lake will give an answer to the question.

- The problem of the silting up of the Great Lake first is thus transferred to the VEAL POK area, where we believe the maximum silting up caused by the Mekong to occur. The survey undertaken this year by the French Sedimentation Mission in that region will make it possible to concretize these data.

Done in PHNOM-PENH, 8 July 1963

(signed)

J.P. CARBONNEL